PACIFIC COAST STATES

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Cloudiness along the Pacific coast is caused by three major meteorological processes and each process produces a separate type of ceiling. First, forced ascending currents of moist air over mountain ranges and in cyclonic circulations produce the greatest amount of cloudiness and the greatest variance in heights of ceiling. Since Washington and Oregon are nearer to the normal paths of storms entering the continent, the region from the Pacific Ocean to the Cascade Mountains and from extreme northern California to the Canadian border is the cloudiest on the Pacific slope.

There are five mountain ranges averaging from 3,000 feet to 8,000 feet (900 to 2,400 meters) elevation lying across the airway between Los Angeles and Portland. The amount of cloudiness and ceiling heights over these mountain ranges depend upon the strength of the cyclonic winds of oceanic origin together with the proximity of the barometric depression. Ceilings are always higher over the valleys and lower in the mountains when cyclonic conditions produce cloudiness. A very general rule in estimating the degree of safety for a proposed flight over mountain ranges on the Pacific coast is as follows: With airway weather reports along the proposed flight showing varying amounts of cloudiness and heights of ceiling, and a weather map showing a cyclonic circulation bringing winds from the Pacific, the possibility of flight over the mountain ranges on the average is inversely proportional to the pressure gradient. For example, under the above conditions a barometric pressure gradient of less than 0.10 inch in 300 miles (2.5 millimeters in 500 kilometers) would indicate a flight could probably be made on schedule; a pressure gradient of from 0.10 to 0.20 inch in 300 miles (2.5 millimeters in 500 kilometers) would indicate cautionary flying weather with a possibility of getting through; a pressure gradient of 0.20 to 0.30 inch in 300 miles (5 to 7.5 millimeters in 500 kilometers) usually means impossible and dangerous flying weather.

The second process through which considerable cloudiness is produced on the Pacific coast is a radiation process and occurs mainly during the late spring, summer, and early autumn. During this period of the year the desert regions and interior valleys of California, frequently including the interior valleys of Oregon and Washington, are heated through insolation during the summer days. The temperature in these valleys often exceeds 90° F. (32° C.), resulting in expansion of air over these areas producing a thermal cyclone [5] sometimes called a "heat-low." Cloudiness is seldom present over the area of the thermal cyclone, but cool moist air from the Pacific Ocean flows inland over low ground, bays, inlets, and gaps in the coast hills. Ocean fog and low stratus clouds usually prevail over the ocean along the entire Pacific coast during this season. The movement of cool moist air from the ocean to the land is attended by fog or stratus clouds moving inland but dissipating during the day as it underruns the heated inland air. All land areas from the coast to the mountain ranges near the coast, including all coastal valleys, bays, and inlets are thus filled with cool moist ocean air which has forced the heated dry inland air up to an elevation of from 1,500 to 4,000 feet (457 to 1,219 meters) above the surface. During the night the movement of ocean air inland gradually ceases. Both the warm dry air mass aloft and to a greater extent the cool moist air mass near the surface lose heat during the night due to radiation. Stratus clouds are formed by condensation beginning in the cool moist layer of air near the elevation at which the warm dry air overlies it. Numerous aerographic flights at San Diego by the Navy and eye observations while in flight over the San Francisco Bay area evidence the fact that the top of the stratus cloudiness along the coast is at the elevation where a rapid temperature inversion begins. Since cool moist air movement from the ocean to the land is required the most favorable pressure distribution for the air movement and resultant cloudiness is when isobars are parallel to the coast line. On the other hand, clear skies will prevail along the coast when a high-pressure area is pushing inland near the California-Oregon boundary and isobars are lying at such an angle transversely with the coast that the air movement is practically parallel to it.

Surface humidities of 65 to 70 per cent or greater during the late afternoon at coastal valley stations 10 or 12 miles (16 to 19 kilometers) inland are nearly always necessary for the general formation of the cloudiness in the coastal valleys. Ceiling heights vary from a few hundred feet to extremes of nearly 4,000 feet (1,219 meters) and the thickness of the layer of cloudiness varies from a few hundred feet to sometimes 3,000 feet (914 meters). Undoubtedly the height of ceiling depends upon the depth of the layer of cool moist air moving in from the ocean. This is not easily determined from the surface but an examination of weather maps in relation to ceiling leads to the following general indications:[6] If the thermal cyclone over the interior is long and narrow, the depth of ocean air moving inland will be shallow and ceilings along the entire coast will be low, usually below 1,000 feet (304 meters). If the thermal cyclone spreads out over Nevada and southern Utah ceilings along the California coast will be relatively high, 1,500 to 3,000 feet (457 to 914 meters) due to a deeper stratum of ocean air moving inland. If the northern end of the thermal cyclone is narrow and the southern end is wide, ceilings will be low along the northern California coast and high along the southern California coast. Skies over the interior valleys are usually clear at such times.

The third type of cloudiness or condensation is also a radiation phenomenon, but confined to the interior valleys of the Pacific coast region during the winter months. It is formed at the surface over interior valleys and the ordinarily relatively thin layer sometimes reaches an extreme thickness of nearly 4,000 feet (1,219 meters). An ideal condition for its formation is that following the passage of a cyclone southeastward through Oregon, Nevada, and southern Utah when a strong high-pressure area develops in the rear of the storm over the Plateau region. The interior valleys of California, Oregon, and Washington become filled with moist air during the passage of the storm and after skies have cleared, outgoing radiation exceeds incoming radiation, with a resulting net loss of heat. In this case temperature inversion is at the surface with radiation greatest near the ground, hence condensation begins at this level and proceeds upward. Because of the short days and long nights, insolation can not overcome radiation and the fog continues to build up over the interior valleys for sometimes as much as three weeks at a time. The

[5] Monthly Weather Review, August, 1929, The West Coast Atmospheric Fault, by Edward H. Bowie.

[6] Studies of George M. French, Weather Bureau official at Los Angeles, Calif.

ceiling is usually on the ground during such periods, but often lifting during the middle of the day. A change in pressure distribution producing moderate to fresh upper air winds is required before the fog or condensation is driven out of the interior valleys by air movement.

Visibility in the Pacific coast region may be said to vary with the seasons, if restricted visibility due to fog or storms is not considered. During the late spring, summer, and early autumn very little precipitation occurs over the entire area and upper air winds are usually light. Consequently the air over the area from the Rocky Mountains westward accumulates haze and forest-fire smoke during the season and is seldom washed out by rain or drifted away fast enough by air movement. If the season is unusually dry, forest fires are numerous and a smoky condition steadily increases as the season progresses. During the 1929 season, for example, visibility was reduced to one-fourth mile (0.4 kilometer) over Washington and Oregon, with smoke extending up to 10,000 feet (3,047 meters), resulting in suspension of much flying during a 2-weeks period in August of that year. A general rain over the district during such a period will clear the atmosphere and visibility will remain good for a week or 10 days following. Strong northerly winds at moderate and high elevations will always clear the atmosphere and make visibility excellent for several days. During "north-wind days" pilots have many times reporting seeing Mount Rainier, near Seattle, Wash., and Mount Shasta, in northern California, while flying at high elevations over central Oregon.

At times of marked temperature inversion there is an optical phenomenon known as a mirage, which affects the earthward visibility for a pilot flying above the inversion surface. It is more pronounced during the summer period and near the coast where the inversion is greatest. From the air it may be so pronounced as to have the appearance of a layer of fog, except that directly below the plane, ground objects can be faintly seen. From a point near the level where inversion begins, the top of the cool moist layer has the appearance of a line on the horizon above which an apparent layer of exceptionally clear air about 1° wide prevails. This reflection phenomenon appears to the pilot during the daytime and disappears to him at night. Cities and airports not discernible at an angle from the plane during the day are readily seen under the same conditions at night and the false impression to the pilot is that smoke, haze, or fog has disappeared.

AVERAGE VISIBILITY AT CHICAGO AIRPORT

By F. H. WECK

The accompanying figure shows the daily march of horizontal visibility at the Chicago Airport for the first three months of 1930. The main contributing factor of reduced visibility is one of smoke. Contrary to the old adage, the darkest hour is not just before the dawn.

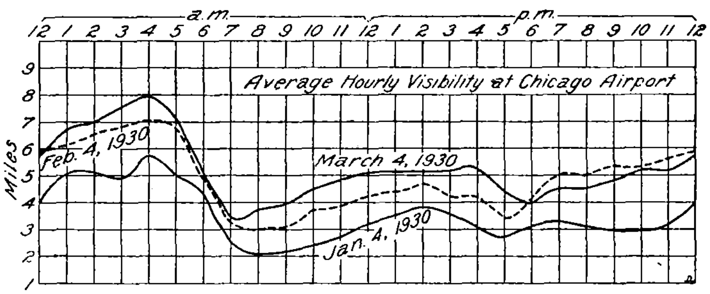

FIGURE 1.—Daily march of horizontal visibility, Chicago Airport, January, February, and March, 1930

Stoking furnaces in homes fills the air with smoke after the man of the house arises, and the visibility falls rapidly. As the day advances the smoke becomes lighter and the visibility improves. Then in the early morning there is more haze and fog which disappear with the rise in temperature.

Firing in the afternoon at residences and banking furnaces at factories again reduce the visibility, after which it begins to rise. From the graph it appears that mail planes would have better flying conditions if they were scheduled to arrive in Chicago between 1 and 4 a. m. Most of them are due at from 5 to 8 a. m. and from 6 to 8 p. m.

As a further evidence that the visibility varies inversely as the amount of coal consumed, it is noted that from 6 p. m. till midnight the average visibility was less for March than for February. The mean temperature at 7 p. m. was 37.8° for February and 36.3° for March. Also the 7 a. m. mean temperature was 31.5° for February and 29° for March, but there was more fog during the month of February.

The average visibility for January was 3.6 miles, for February 4.8, and for March 5.2.

There is no scientific method used in obtaining values of visibilities. The ground around the airport is more or less level and a number of "visibility points" of known distance from the place of observation afford fairly reliable data.